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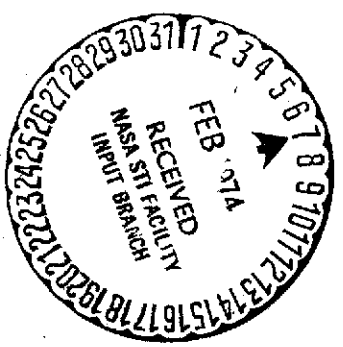

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16. Abstract The urinary calcium excretion was determined in 22 patients immobilized because of myocardial or pulmonary infarction and thromblophlebitis of the inferior extremities. Among the 18 subjects in whom the daily urinary calcium output was estimated at the beginning and toward the end of the immobilization period, the calcium excretion increased in 15 patients. In 10 cases the rise was more than 100%; during the first examination it was, on the average, 115 mg calcium per 24 hours, whereas after immobilization the value attained was 259 mg. The rise in the calcium output was more pronounced among subjects who had previously been very active. Following immobilization, the calcium level in the blood increased from a mean of 9.7 to 10.4 mg per 100 ml of serum.

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EFFECT OF IMMOBILIZATION ON THE URINARY EXCRETION OF CALCIUM

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A balance between bone absorption and bone formation is /1921* maintained in a healthy adult. A sufficient amount of proteins, vitamins, of the growth hormone, and sex hormones is required to maintain this balance, since only under these conditions can the osteoblasts fulfill their function. In addition to these factors, in order to maintain regular osteoblast activity they must be stimulated mechanically by movement [3, 4, 5, 7, 11]. When the urge to move, which stimulates the osteoblasts becomes weaker, their activity also decreases. This is followed by dominant osteoclastic activity of the osteoclasts, and bone absorption dominates bone formation until the calcified bone mass returns to the new balanced state required by the new situation [6, 7, 10]. This increase in bone absorption leads to a rise in the calcium level in the blood, which is immediately balanced, mainly through increased urinary excretion [13]. From Doering's studies in 1963 of the calcium balance in the human organism with the aid of marked calcium it appears that a relationship exists between the 24-hour urinary calcium excretion and the total amount of calcium eliminated from the system [2].

On the basis of these data in the literature, we investigated the 24-hour urinary calcium excretion in patients who have been immobilized for a short period due to various internal diseases.

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* Numbers in the margin indicate pagination in the foreign text.

Material and Methods

The 24-hour urinary calcium excretion was determined among 22 patients who spent a period of 21-32 days in bed, in complete rest, due to a basilar disease. The principles for absolute inert rest were observed strictly, and only small movements of the extremities were allowed. The patients were constantly in an inert, lying position and were fed in this position. Patients who did not observe absolute inert rest in bed were not considered in this study. The age of the persons analyzed varied from 34 to 73 years. The analyzed group included 17 men /1622 and 5 women. Eighteen patients were treated for a myocardial infarction, two for thrombophlebitis of the inferior extremities complicated by a pulmonary infarction, one for thrombophlebitis of the inferior extremities and one for a myocardial infarction complicated by a pulmonary infarction.

Among 18 patients the amount of calcium excreted in urine in /1623 24 hours was determined twice. The first study was made after 5-10 days of immobilization, and the second after 21-32 days. Among four patients only one study was made after roughly 3 days of immobilization. The amount of calcium excreted through the urine by the last patients was compared with the mean amount of calcium excreted by the remaining patients at the beginning of the immobilization. Before each study, the patients received a low-calcium diet for a 3-5 day period, in accordance with Bauer and Auba [1], which contained about 105 mg of calcium in a 24-hour period. To eliminate possible disturbances in the calcium balance connected with a cardiogenic shock as well as with the serious condition of the patients in the first days of observation, the patients received the low-calcium diet after 3-4 days of immobilization. On the fourth or fifth day, when the patients were given the diet according to Bauer and Auba, the urine was collected for 24 hours,

suggesting a complete empyting of the bladder before the beginning of the collection as well as after its completion. Together with determining the amount of calcium excreted in the urine, we also simultaneously described the calcium level in the serum. The calcium level was estimated using the Kramer and Tisdall method [12].

Results

Among 18 patients who were studied, in whom the amount of calcium excreted in the urine was determined twice, it increased considerably in 15 persons after immobilization; in one patient this increase was slight, and among two persons, the calcium excreted with the urine decreased slightly. Among four persons in whom it was determined only after immobilization, the calcium excreted in the urine was high in three patients and low only in one patient. The arithmetic average which was calculated from the amount of calcium excreted in the urine in 24 hours in the first days of immobilization was 115 mg per 24 hours, and after 3-5 weeks of immobilization, 257 mg per 24 hours. Hence, it was 2.3 times as high after immobilization as before immobilization.

Among the 18 persons studied, in whom the calcium level in the serum was determined twice, the calcium level increased in 12 cases, and decreased in 6 cases after immobilization. The arithmetic average from all determinations at the beginning of immobilization was 9.7 mg % per 100 ml of the serum, and, after the immobilization, 10.4 mg % per 100 ml serum. Hence, it was somewhat higher after the immobilization, but both values are still within the norm (Table 1).

Discussion

Among patients in whom the amount of calcium excreted in the urine in 24 hours before and after immobilization was determined, this value increased among 83% of the persons examined. This increase was the result of the osteoclastic activity, which dominated the activity of the osteoblasts, which were not stimulated by movement as a result of the immobilization and therefore decreased their activity, causing a preponderance of bone deterioration over bone formation.

Table 1 and Fig. 1 show that, among the patients denoted by the numbers 2, 3, 7, 10 and 13, the increase in the calcium excreted in the urine was generally high. All these people either worked very hard physically or led a very active life immediately before the immobilization. They excreted 450, 430, 472, 387 and 720 mg calcium per 24 hours after immobilization. Evidently, a sudden immobilization of people who were very active physically before the immobilization leads to a drastic increase in bone deterioration with a subsequent increase in the calcium excreted in the urine in 24 hours.

Table 1 and Fig. 1 refers to the three patients denoted by numbers 1, 19, and 22, in whom a drop or slight increase in the amount of calcium excreted in the urine occurred after the immobilization. Among these, two patients were seriously ill in whom the basic disease was accompanied simultaneously by heart failure. The third patient, who was 73 years old, had advanced senile osteopsathyrosis, which undoubtedly reduced his ability to mobilize the calcium after immobilization. This patient led a relatively inactive life before the myocardial infarction, which he changed somewhat by adopting the infarction regime. We explain the absence of an increase in the calcium excreted in the urine of this patient by these reasons.

/1624

TABLE 1

Patient No.	Sex	Age	Study I			Study II			Diagnosis	Remarks
			Immobilization period days	Calcium in serum in mg/100 ml serum	24-hr calcium excretion in mg	Immobilization period days	Calcium in serum in mg/100 ml serum	24-hr calcium excretion in mg		
1	M	34	7	8.2	68.2	27	9.9	65.0	Myocardial infarction and pulmonary infarction	Heart failure
2	M	37	8	8.2	53.5	31	8.6	450.0	Thrombophlebitis of the inferior extremities complicated by pulmonary infarction	Farmer, heavy physical labor
3	M	38	9	11.3	48.7	28	9.6	430.9	Myocardial infarction	Athlete
4	M	42	7	11.0	45.5	28	12.2	283.9	Thrombophebitis of inferior extremities complicated by myocardial infarction	
5	F	42	10	9.7	86.6	27	12.0	192.0	Myocardial infarction	
6	F	43	—	—	—	21	9.7	220.6	Thrombophlebitis of inferior extremities complicated by pulmonary infarction	
7	M	51	5	8.6	282.0	31	11.6	472.0	Myocardial infarction	Farmer, suddenly immobilized
8	M	53	5	10.6	249.6	25	10.8	274.0	Myocardial infarction	
9	M	55	—	—	—	24	11.5	273.6	Myocardial infarction	
10	F	56	7	10.3	138.6	26	8.9	387.0	Myocardial infarction	Female farmer
11	M	57	10	9.7	146.1	31	9.9	255.6	Myocardial infarction	
12	M	57	8	9.8	88.0	28	11.4	141.0	Myocardial infarction, overweight	
13	M	58	6	10.6	240.0	29	12.6	720.0	Myocardial infarction	Very active life
14	M	58	8	9.7	114.0	31	11.5	241.7	Myocardial infarction	
15	M	60	6	9.9	77.5	24	9.8	131.5	2nd myocardial infarction	
16	M	62	9	10.2	130.4	27	9.8	195.1	Myocardial infarction	
17	M	63	9	9.8	101.2	25	9.4	171.8	Myocardial infarction, rheumatoid arthritis	
18	F	64	—	—	—	22	9.2	336.7	Myocardial infarction	
19	M	64	7	7.6	51.4	24	9.4	68.0	Myocardial infarction with aneurism	Heart failure in left ventricle
20	F	64	—	—	—	22	8.2	86.6	Myocardial infarction	State after myocardial infarction
21	M	65	7	11.2	38.3	32	11.1	206.6	Myocardial infarction	
22	M	73	6	9.2	109.2	32	11.8	95.2	Myocardial infarction	Advanced osteopsathyrosis
Arithmetic average			9.7	115.0	—		10.4	257.0		

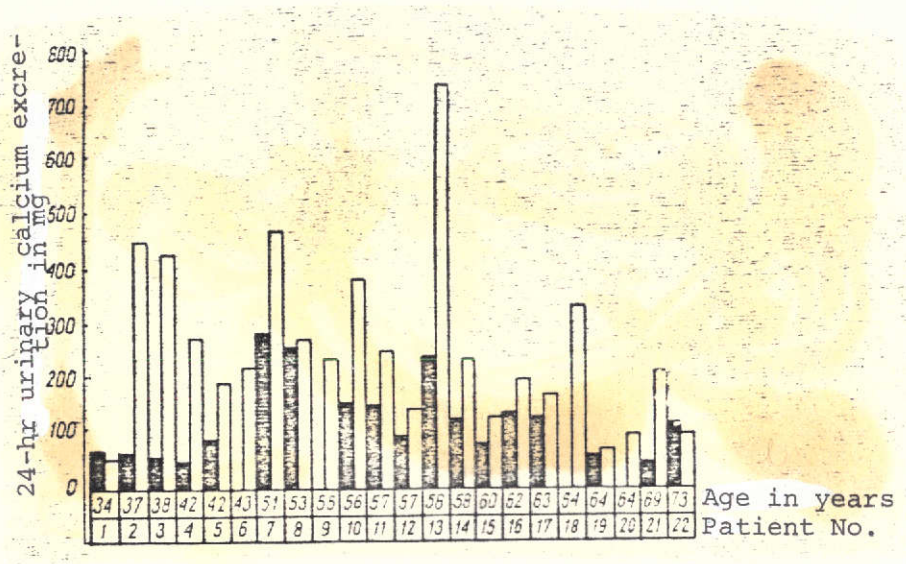

Fig. 1. 24-hour urinary calcium excretion in mg.

Wernly [13] reports that a healthy person compensates without difficulty fluctuations in urinary calcium excretion without any damage to the system, provided these fluctuations are 50-100% above or below the norm limit. However, if they exceed this limit, disturbances may occur, for example, in the form of stones formed in the urinary tracts [8, 9, 11]. In our 22 patients, the calcium excreted in the urine exceeded the norm by 100% in 10 cases, which happens relatively frequently already after a short immobilization. We did not discover any complications connected with hypercalciuria, probably because the immobilization was relatively short.

Conclusion

1. The 24-hour urinary calcium excretion increases considerably among people after complete immobilization lasting several weeks (on the average from 115 to 257 mg/24 hours).

2. Among 22 people examined, the urinary calcium excretion exceeded the upper norm limit by 100% in 10 cases.

3. The urinary calcium excretion increases most among people who were very active physically immediately before the immobilization.

4. The calcium level in the blood increases after immobilization (on the average from 9.7 to 10.4 mg per 100 ml serum). However, its arithmetic average lies within the limits of the norm. /1625

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